



Au1X00

Video decode for less than 1W

Agenda



- Demonstration
- Three main topics:
 - **The Au1100™ Processor (and family)**
 - **Video performance in Au1X00 systems**
 - **System performance issues in embedded systems**
 - **Video performance on Au1X00 systems**
 - **Power dissipation while displaying video**
- Summary and conclusions

Video demonstration



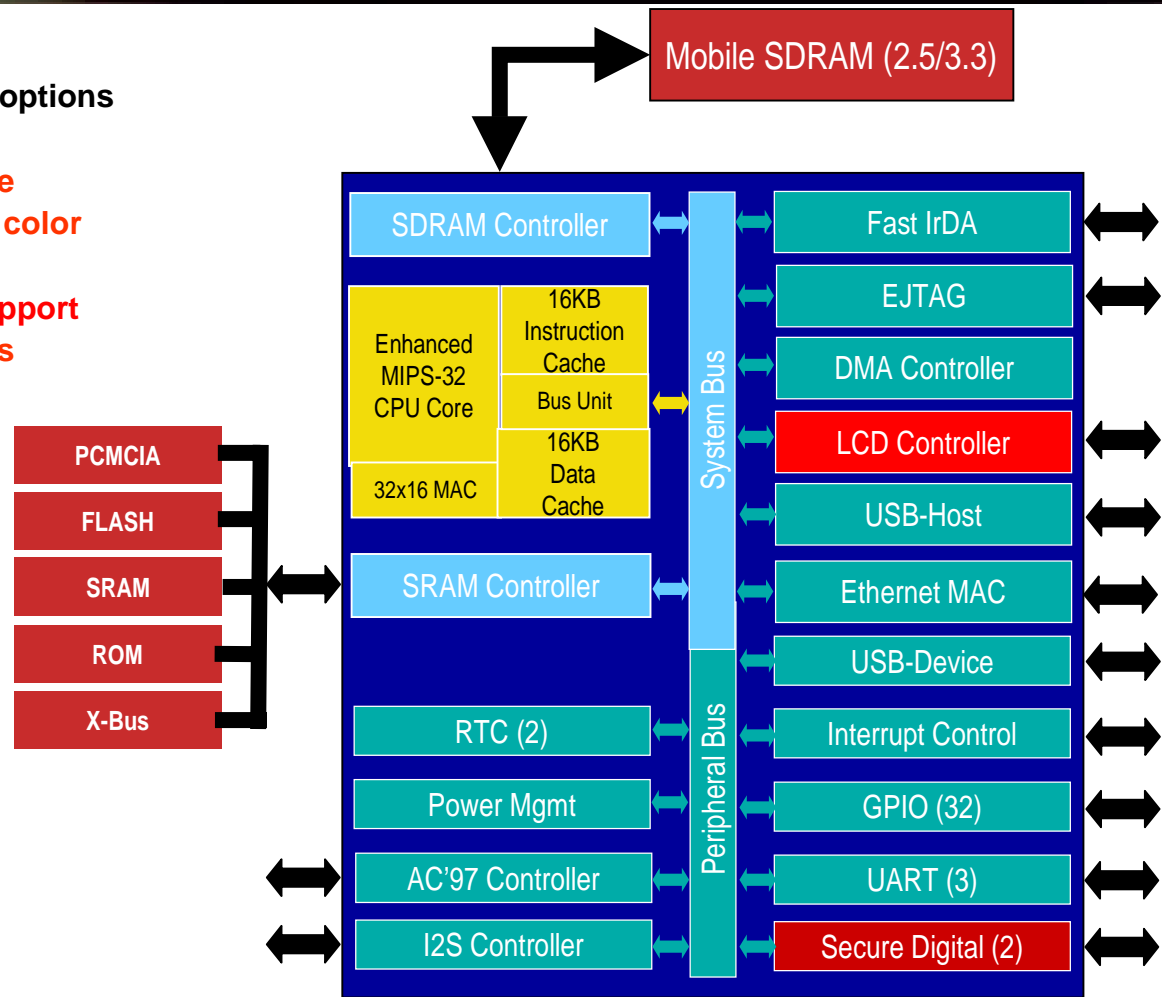
- What you just saw:
 - MI-2 movie trailer
 - Encoded at:
 - MPEG1 encode
 - 400 x 200 window size
 - 1100 kbps bit rate
 - 24 Frames per Second
 - Playback setup
 - MediaPlayer™ video player
 - WindowsCE™ OS
 - Played on
 - Pb1100 development platform
 - Au1100
 - 0.13um
 - 396MHz
 - <<500mW power

Au1100™ Processor

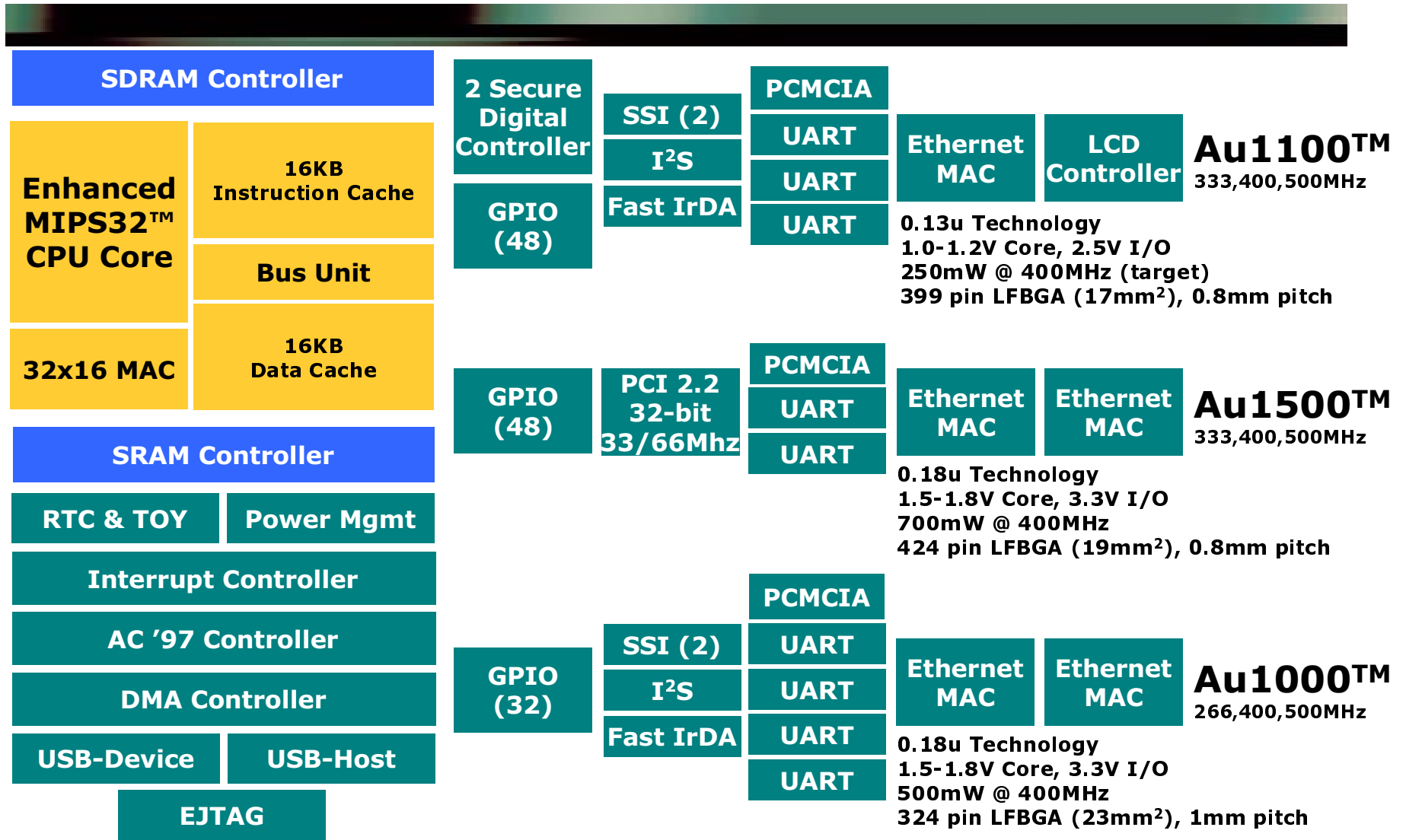
The first 0.13um AMD SOC



- **Alchemy Au1 Core**
 - 333, 400, and 500 MHz core options
- **LCD Controller**
 - Unified Memory Architecture
 - All panel types, up to 16-bit color
 - Hardware rotate (QVGA)
- **2.5 Volt/3.3Volt Mobile SDRAM Support**
- **2 x Secure Digital / SDIO Interfaces**
- **Ethernet MAC**
- **3 UARTs**
- **USB Host and Device**
- **Fast IrDA**
- **GPIO (TBD)**
- **AC'97**
- **I2S**
- **TSMC 0.13μ Process**
- **Low Power Consumption**
 - 1.0 - 1.2V Core
 - 3.3 V I/O
 - 250mW @ 400MHz
- **Package**
 - 399 Pin PBGA, 17 x 17 mm²



Au1X00 SOC comparison



System-level Video Performance Issues



- Computation requirements of video decode (MPEG4/1)
- Memory system bandwidth utilization
- Performance/overhead of networking solution
- Integration/synchronization of audio and video outputs
- Can video decode be done in software on a <1W power budget?

Computational Components of Video Decode



- We studied 2 of the dominant components in MPEG4 video decode
 - Inverse Discrete Cosine Transform: up to 40%
 - Color Space Conversion: up to 25%
- Performance measured by two benchmark tests
 - IDCT loop: 81000 block transforms
 - CSC loop: 81000 YCbCr->RGB 8x8 block conversions
 - Results should be dominated by CPU, not memory system.

Projected Decode Performance



- Performance measurements/projections
 - Projected frames per second (FPS) are approximate

	CPU Cycles per CSC	CPU Cycles per IDCT	Projected FPS, 320x240, 504MHz
Au1500	~5050	~2675	26

- Benchmark measurements project full frame rate decode

System Performance Issues

Bus/Memory Bandwidth Utilization



- Bandwidth to/from frame buffer is valuable resource
 - Unified/Split memory architectures have very different performance characteristics

- There may be many consumers of bandwidth
 - Ethernet, video decode, frame buffer updates, audio, GUI overhead, USB mouse/keyboard input
 - Bus arbitration fairness may be an issue for satisfying real-time requirements of video display
 - The AuSB protocol supports shifting bandwidth allocation towards high-priority consumers.

Au1X00 Video Solution Bandwidths



- The effective bandwidth to the frame buffer varies widely depending on the video solution.
- Au1000™ Processor:
 - Glueless interface to inexpensive, low-power Epson controllers
 - 16-bit, 25-50MHz interface
- Au1500™ Processor:
 - Any PCI-based graphics solution
 - Example: ATI Xpert 98
 - 33MHz, 32-bit PCI interface
- Au1100™ Processor:
 - Integrated LCD controller
 - Full speed read/write access to SDRAM based frame buffer

Video Display System Bus Bandwidth Requirements



- For video decode, bandwidth usage will be dependent on the frame buffer update rate.
 - For example: at 30FPS, 16-bit color the bus bandwidth required is:

	FB write (MB/s)
QCIF (176x144)	1.5
SIF (320x240)	4.6
CIF (352x288)	6.1

- The complete decode operation will use 1.5-3X this much memory bandwidth depending on the details of the encoding scheme used.
- Available Au1X000 FB bandwidth:
 - Au1000™: good for lower end of the performance range
 - Au1500™ and Au1100™: cover full spectrum of decode performance

Memory System Impact



- Memory system dependence
 - The CPU-dominated benchmarks show a second-order dependence on the memory system.

	CPU Cycles per CSC	CPU Cycles per IDCT
Au1500, 396MHz, PCI graphics	~5050	~2675
Au1100, 396MHz, QVGA panel	~5500	~2850
Au1100, 396MHz, VGA panel	~5975	~3150

Video Display System Bus Bandwidth



- With a UMA display controller like the Au1100, a dominant bandwidth consumer is screen refresh.
 - Screen refresh accesses frame buffer at full SDRAM rate

	Refresh BW (MB/s)	% of AuSB BW w/ 100MHz SDRAM @ typical access rate
QVGA (320x240)	11.7	5.6
VGA (640x480)	46.9	22.3
SVGA (800x600)	73.2	34.8
XGA (1024x768)	120.0	57.0

- The Au1X00 systems are very capable of supporting quality video decode solutions – what about power?
- The keys to power dissipation
 - Managing power in both Active and Idle processor states
 - Leveraging technological developments
 - High frequency operation allows more time spent in Idle

Au1X00: Managing Power



- Au1X00 family is designed for low-power operation
 - Custom circuit design allows high-speed operation at low voltage
 - Very aggressive use of clock gating
- At the system level the Au1X00 solutions allow:
 - Multiple frequency scaling options
 - Support for static, semi-static and dynamic frequency changes.
 - Dynamic Voltage scaling
 - Power supply can track the operating frequency:
 - 500MHz/1.8V, 400MHz/1.4V, <333MHz/1.2V
- Typical Au1X00 Active:Idle power ratio: 3-4X

Technology Enhancements



- Power savings from moving to 0.13um and Mobile SDRAM
 - Core nominal operating voltage
 - 1.4V -> 1.0V reduces core power by ~2X
 - Mobile SDRAM
 - 3.3V -> 2.5V reduces I/O power by ~1.75X
 - The new SDRAMs also have additional power saving modes

Au1X00: Idle Time



- Active:Idle ratios while playing video clips

System	Video clip encoding	% idle	Chip power
Au1500, ATI PCI card	Low complexity	85-90	<300mW
Au1500, EPSON controller	Low complexity	45-50	500mW
Au1500, ATI PCI card	High complexity movie trailer	30-35	600mW

- High performance design reduces system power

- Good video performance does not require high power
- Demonstrated full frame rate video decode at $<0.5W$
- The Au1X00 family allows tuning system performance and power to meet a range of applications.

Trademark Attribution



AMD, the AMD Arrow logo and combinations thereof, Au1000, Au1100 and Au1500 are trademarks of Advanced Micro Devices, Inc. MIPS32 is a trademark of MIPS Technologies, Inc. Other product names used in this presentation are for identification purposes only and may be trademarks of their respective companies.